APPENDIX C

1988

STRIPED BASS RESULTS

12 August 1988

Dr. Chris Foe
Regional Water Quality Control Board
3443 Routier Rd.
Sacramento, California 95827-3098

Dear Dr. Foe:

Attached is the revised report regarding the toxicity of the water samples you submitted for testing with larval striped bass. As you will note, the revisions provide greater clarification of the study's details and conclusions.

If you have any questions regarding the report or the data, please call me at 752-1484. In addition, if we can provide any further assistance, please feel free to contact us.

Sincerely,

Howard C. Bailey

cc. S. Doroshov
J. van Eenennaam

Response of Larval Striped Bass to Agricultural Drainage and Sacramento River Waters

Sample Series 1

The first series of samples were collected by Central Valley Regional Board staff on May 15 and stored at 4 °C in brown amber bottles until testing. Our laboratory received them on 23 May 1988 and commenced testing on 24 May. One sample was labelled Colusa Basin Drain (CBD) and the other was labelled Rio Vista. In addition, two control samples were received in which the conductivities were matched to the test waters by the addition of seawater. The exposure was conducted in 1-L glass beakers containing 700 ml of test medium. Each beaker was rinsed out with the test solution before adding the 700 mL. The test temperature was 17°C. The test was initiated by adding 4-day old larval striped bass (obtained as 3-day old larvae acclimated to 3 ppth seawater from CFG's Central Valley hatchery)by pipet to each beaker. Each treatment was conducted in duplicate. Because the larvae were being held in 3 ppth seawater, a control using this water was also added to the test series. The results are summarized below.

Table 1. Mortality of larval striped bass (number dead/number exposed) in agricultural drainage and Sacramento river water (Sample 1).

	Exposure Time	
Treatment	10 Min	25 Min
CBD A	12/16[a]	15/16[a]
B	10/20[a]	14/20[a]
Control A	0/20	2/20
B	6/29	15/29
Rio Vista A	9/16[a]	13/16[a]
B	7/15[a]	11/15[a]
Control A	3/21	6/21
B	2/22	5/22
Control (3 ppth) A	0/11	0/11
B	0/11	1/11

[a] Statistically significant, $p<0.05$.

The presence of an effect in the treatment controls but not in the higher salinity water suggested that at least part of the response could be due to osmotic stress. However, the fact that the responses observed in the CBD and Rio Vista waters were significantly different from their respective controls suggests that there was additional toxicity associated with these treatments. The problem of osmotic stress was addressed by repeating the experiment immediately with new solutions adjusted to a salinity of 3 ppth by adding 70 ml of natural seawater. The results of this experiment are summarized in Table 2 and also show higher mortalities in the salinity adjusted

CBD and Rio Vista samples, compared with their respective controls which also received salinity adjustments.

Table 2. Mortality of larval striped bass in agricultural drain water and Sacramento river water with the salinity adjusted to 3 ppth (Sample 1).

		Exposure Time	
Treatment		24 hr	96 hr
CBD	A	3/27[a]	3/27[a]
	B	3/50[a]	3/50[a]
Control	A	0/34	0/34
	B	0/45	0/45
Rio Vista	A	13/26[a]	13/26[a]
	B	5/39[a]	5/39[a]
Control	A	0/40	0/40
	B	0/36	0/36

[a] Statistically significant, $p<0.05$.

Sample Series 2

A second series of samples was collected on June 1 and tested on 18 June 1988. The samples were stored at 4°C until testing. These samples were labelled Shasta Dam, Station 18 (Sacramento river at Isleton), Station 5 (Sacramento river at Hamilton City), and CBD. This test series used 5-day old larvae (again obtained from the Central Valley Hatchery and previously acclimated to 2.5 ppth salinity) and a solution volume of 1-L. The salinity was adjusted to 2.5 ppth with the addition of 80 mL of natural seawater. The test temperature was 19°C. The results are shown below in Table 3.

Table 3. Sample 2--Mortality of larval striped bass in agricultural drain water and Sacramento river water with the salinity adjusted to 2.5 ppth.

		Exposure Time	
Treatment		24 hr	96 hr
Shasta Dam	A	1/34	1/34
	B	1/21	1/21
Station 18	A	1/27	4/27
	B	1/19	1/19
Station 5	A	1/24	2/24
	B	2/23	2/23
CBD	A	1/31	9/31[a]
	B	4/25	5/25[a]
Control	A	1/33	3/33
	B	1/26	2/26

[a] Statistically significant, $p<0.05$.

Sample Series 3

A third sample was received on 21 June 1988. It was labelled CBD and was taken on 3 June 1988. The bioassay was conducted as described above except that the larvae were 12 days old. Test temperatures ranged between 17.8 and 18.5 ^{o}C. Only one larvae died during the 96 hr exposure period. It was in the CBD sample and occurred at the 72 hr observation point. Thus, this sample demonstrated no acute toxicity to striped bass larvae under the conditions it was tested.

Discussion

The response in each water sample was tested against the appropriate control using the chi square test for independence. For this analysis, the replicates were pooled. In the first test series, both the CBD and Rio Vista samples produced significantly higher mortalities than their respective controls, regardless of whether or not the salinity was adjusted. In the test in which salinity was not adjusted, the mortality in the CBD was 81 percent compared to 35 percent in the control after 25 min of exposure. In the same test, the Rio Vista sample resulted in a mortality of 77 percent compared to a control mortality of 26 percent. After adjusting the salinity to 3 ppth, the controls exhibited no mortalities during 96 hr of exposure while the CBD and Rio Vista samples resulted in mortalities of 8 and 28 percent, respectively. Based on these results, the increased salinity reduced the observed toxicity. Most likely this was due to chemical interactions between the toxic components of the samples and the increased salt concentration, to reduced stress of the larvae in the higher salinity water, or to a combination of these factors. It should be noted that, under natural conditions, the larval striped bass in the Sacramento river are in fresh water (approx. 100 µmho/cm).

In the second group of samples, only the CBD sample resulted in significant mortalities while samples from Shasta Dam, and Stations 18 and 5 did not. After 96 hr of exposure, 25 percent mortality had occurred in the CBD sample, compared with 8 percent mortality in the control.

The third sample of CBD (3 June) produced no effect on mortality. However, a more advanced larval stage was used in this test.

Based on these results, two of the three samples of CBD were acutely toxic to striped bass larvae. In addition, at least one sample from the Sacramento river was also acutely toxic. These preliminary results suggest that, at least some of the time, the Sacramento river is receiving unknown materials in quantities sufficient to produce toxicity to larval striped bass. In Sample Series 1, the higher toxicity of river water at Rio Vista (see Table 2) compared to the toxicity of the sample from the Drain, suggests that other inputs besides the Drain may contribute to the observed mortality. In other words, the toxicity associated with the Drain water itself did not account for all of the mortalities seen in the river water sample taken downstream from the Drain. However, since Rio Vista is 7-10 days water travel time from the Drain, the toxicity associated with the Rio Vista sample would have come from CBD drainage that entered the river at least a week earlier and would not be related to the CBD sample that was taken concurrently. In support of this, the Drain actually appears to be quite variable in toxicity; the three samples that we tested resulted in mortalities of 0, 8, and 25 percent, with the samples that produced 0 and 25 percent mortality being taken only two days apart. This may reflect management practices in the areas that release water to the Drain.

In view of the importance of striped bass as a sport fishery, its recent precipitous decline, and the likelihood that it is not the only species that is being affected, it seems prudent to continue this research to identify the source (s) and extent of the problem. Since the tests described in this report were static acute studies, their sensitivity could be improved by using flow through or static renewal methodologies; both of which have been developed specifically for striped bass larvae in our laboratory. Along these lines, we might suggest that static renewal tests be conducted weekly on samples from various points along the river and from major inputs including agricultural, industrial, mining and municipal sources. This would aid in determining sources of toxicity as well as provide an indication of the extent to which upstream sources (e.g., CBD) contribute to toxicity observed later at downstream sites such as Rio Vista. In addition, the rapid and considerable morphogenetic changes that occur during the development of striped bass larvae suggests that sensitivity to different toxicants may vary considerably, depending upon the stage of development. Thus, initiating exposures at different stages of development would be appropriate in future studies. Finally, based on our data, there are differences in response depending on the osmotic strength of the sample medium. This could have major implications since the very young larvae would be exposed while in relatively soft river water which would probably increase their sensitivity. Consequently, to make the studies "ecologically relevant", we would suggest that the eggs and larvae be reared and tested in water that approximates the Sacramento river in terms of osmotic strength.

Another species which might be considered for testing would be the opossum shrimp, Neomysis mercedis, which occupies a critical position in the food web of the Delta. We have also developed static, static-renewal, and flow-through testing methodologies for this species.